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# Fuel Gas Storage – The Challenge of Methane

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# Methane

- **Methane combustion emits less carbon dioxide (high H to C ratio) than other fossil fuels and less SO<sub>x</sub> and NO<sub>x</sub>**
- **Can be used as a transition fuel for the use of even cleaner alternatives (e.g. hydrogen energy)**
- **Has a higher heating value of 55.50 MJ kg<sup>-1</sup> (compared with hydrogen's 141.80 MJ kg<sup>-1</sup> and gasoline's 47.30 MJ kg<sup>-1</sup>)**

## Methane storage

- As hydrogen, it has a very poor volumetric density (also a gas at normal pressure and temperature)
- To be used in vehicles, it has to improve on its volumetric density (amount per volume) using gas compression, liquefaction or by adsorption
- The goal is to test new porous materials for methane storage and investigate how adsorptive storage compares with other methods

# Equipment



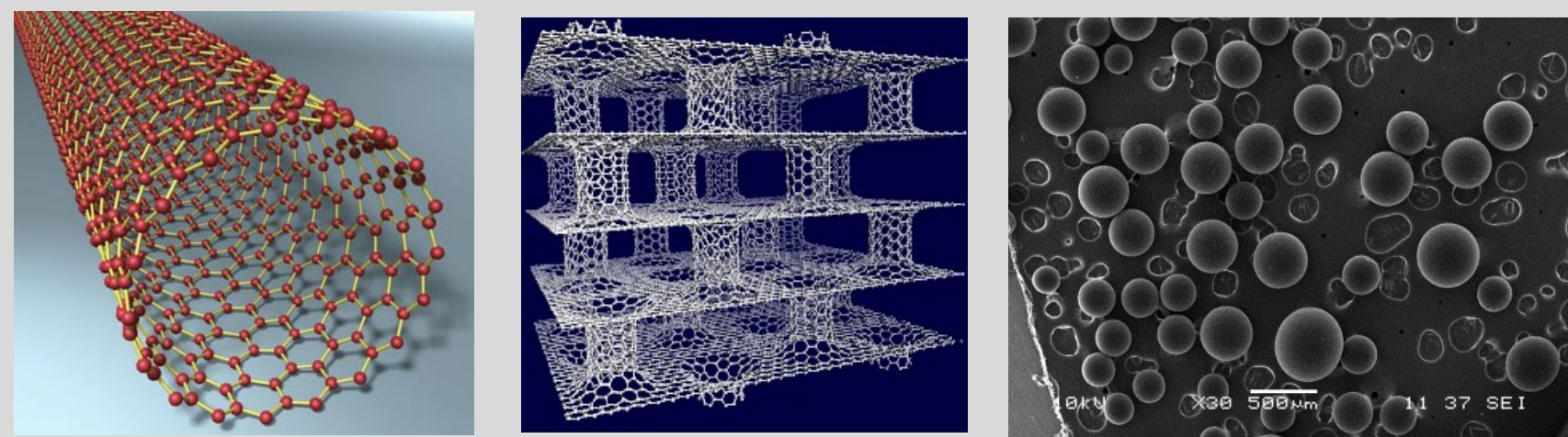
**Clockwise from top left: X-ray diffractometer; IsoEx apparatus, Thermal Gravimetric analyser, HTP-1 volumetric sorption analyser, ASAP 2020 sorption analyser (centre), Helium pycnometer and IGA gravimetric sorption analyser**

# Materials

## Carbons

### Advantages:

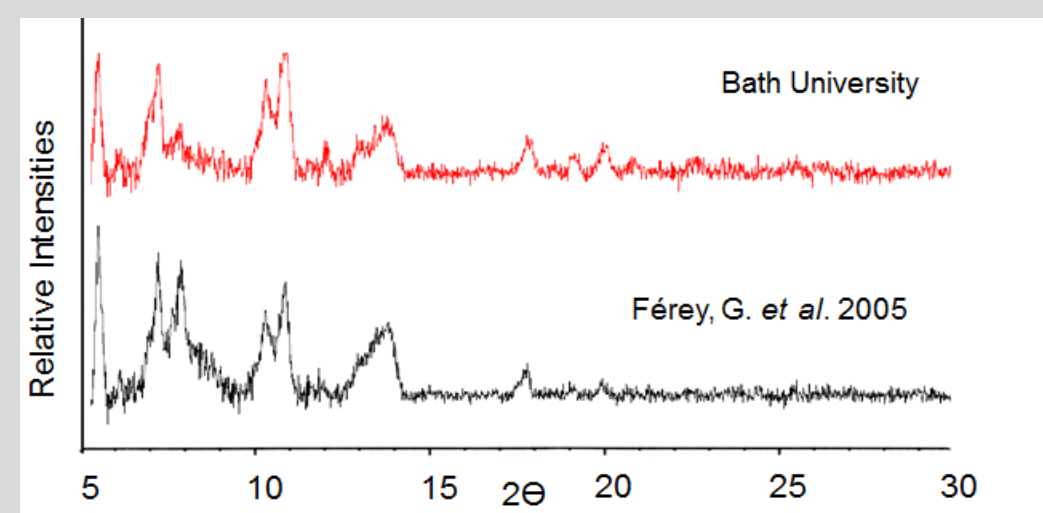
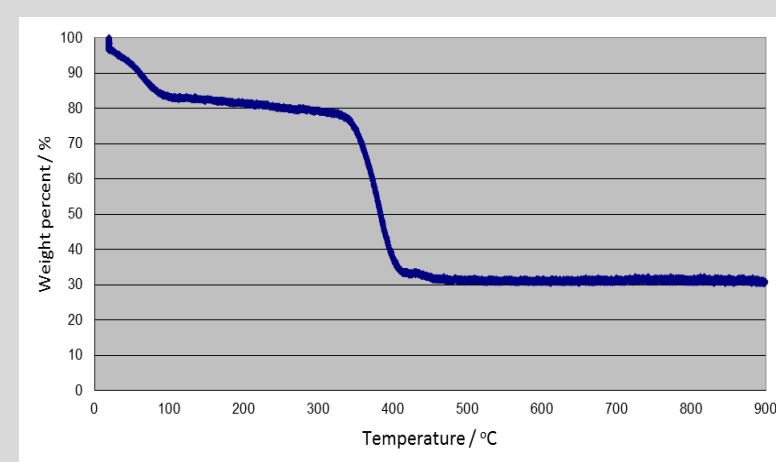
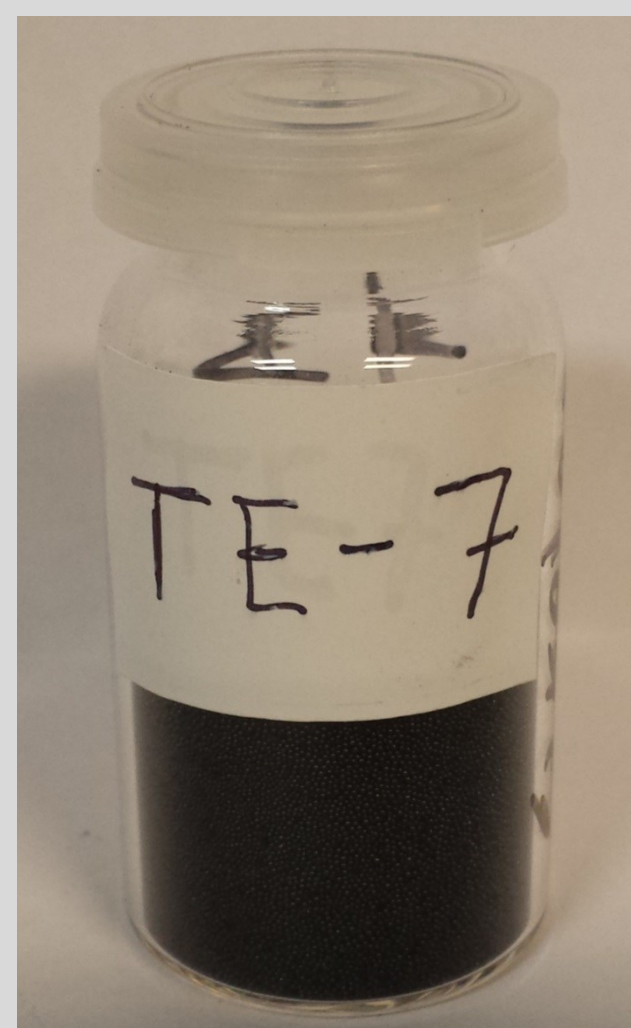
- **Reversible, lightweight and cheap**
- **Wide variety of structural forms**
- **Good thermal stability**
- **Ability to modify the structure**



## Nanotube, Pillared Graphene, carbon beads

# Porous Materials

## MAST TE7 Carbon Beads



## MIL-101(Cr) XRD and TGA

## Metal-organic frameworks

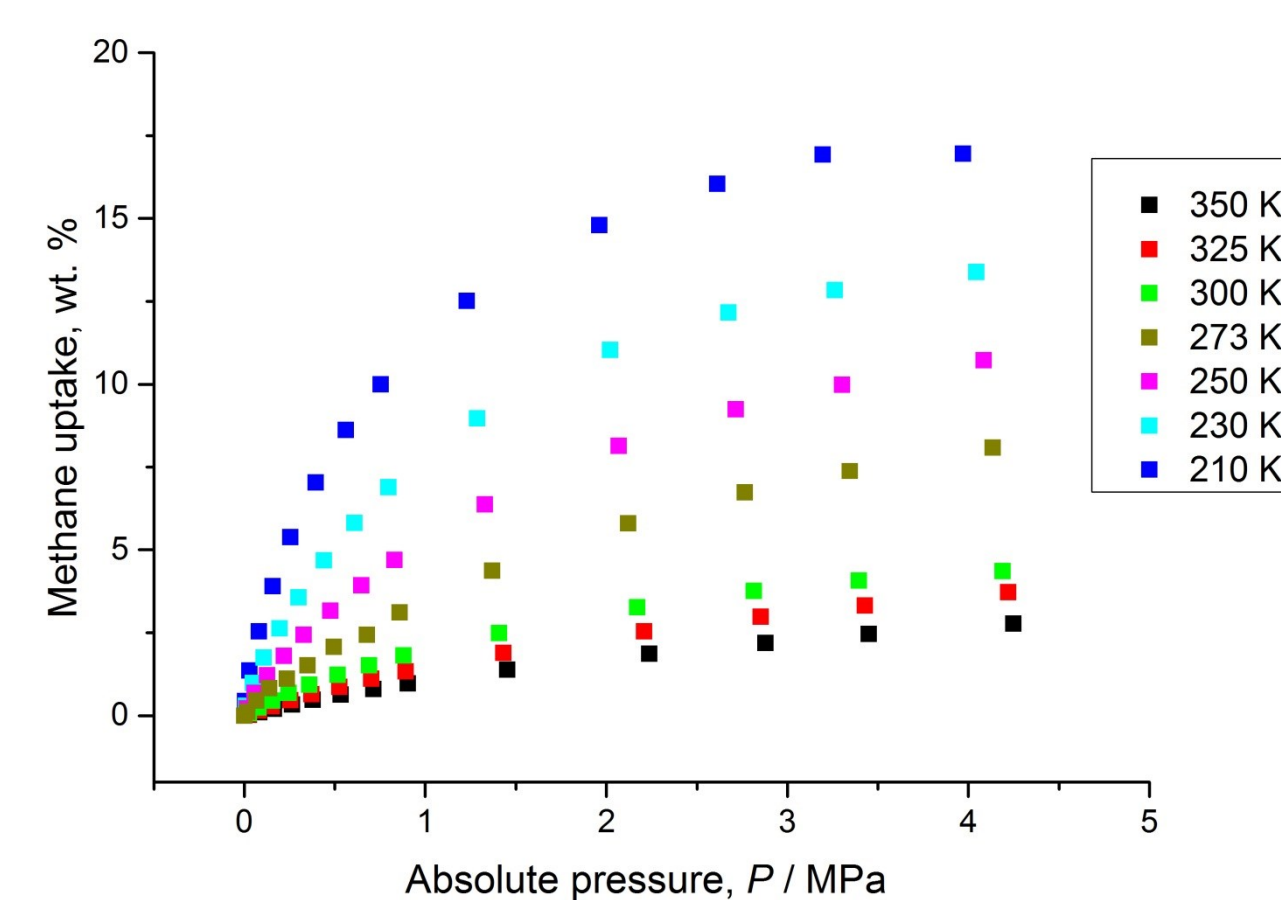
- Metal centres strongly bonded to organic linkers
- High surface area
- Highly tuneable



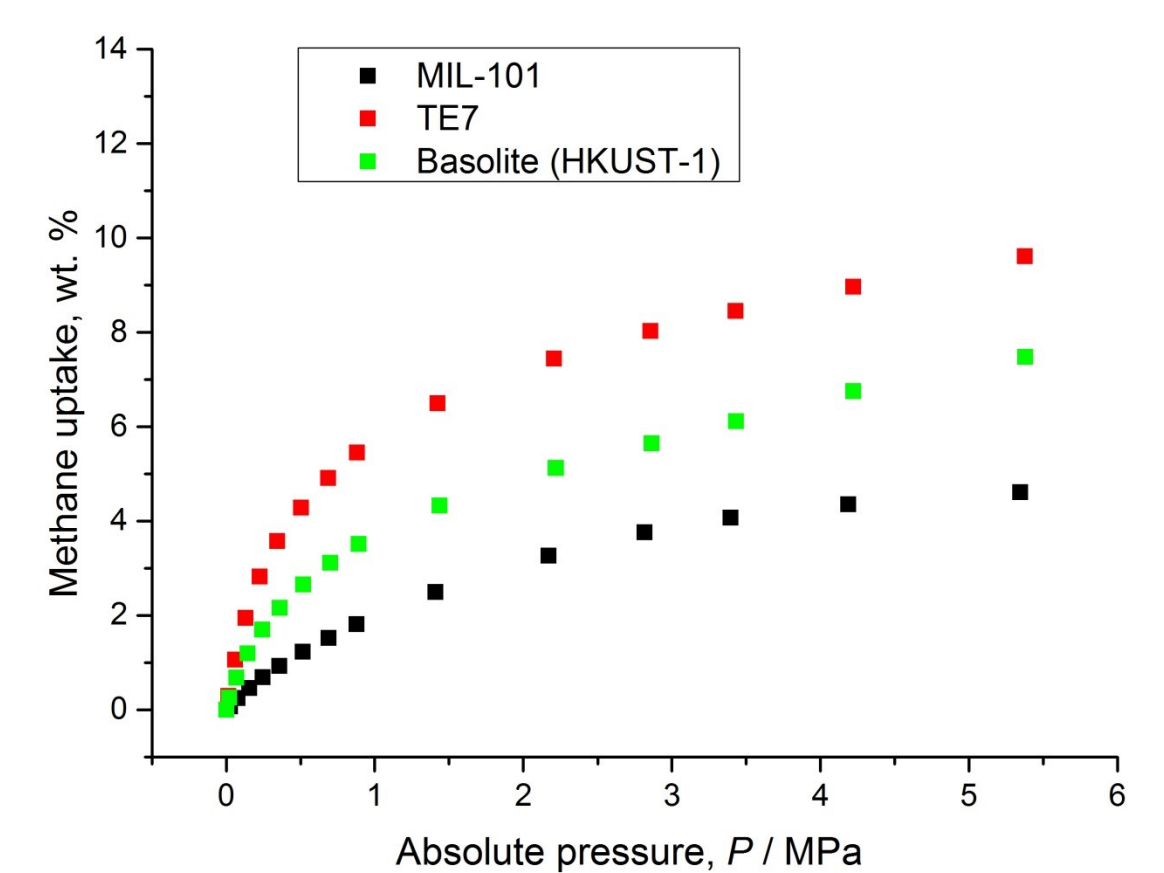
### MIL-101 (Cr) and Basolite samples (HKUST-1)

## Results

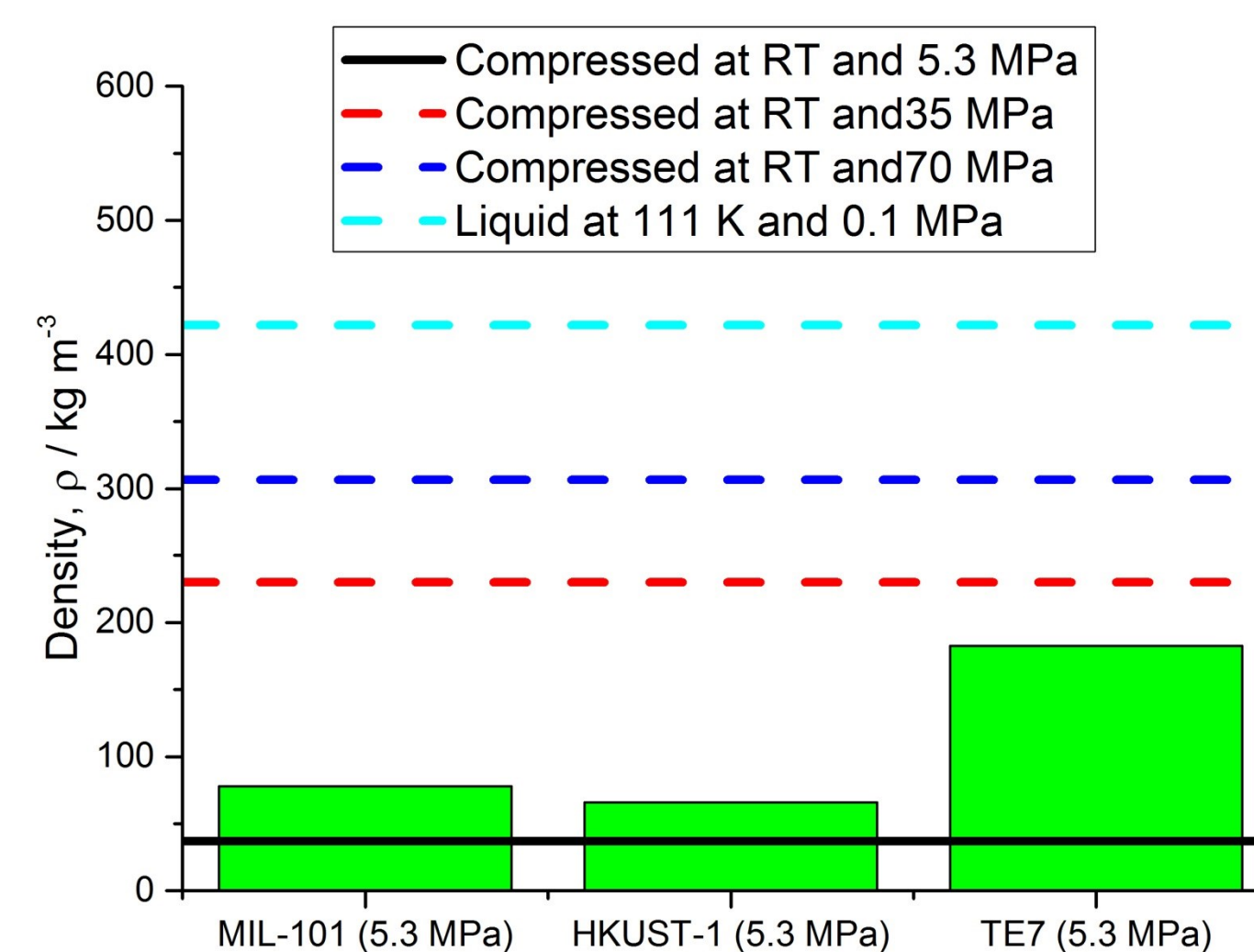
## High – pressure methane isotherms



### Experimental high-pressure methane excess for MIL-101



**Experimental high-pressure methane excess at 300 K for MIL-101, TE7 and HKUST-1**



### Comparative density of adsorbed methane at 300 K

TE7	MIL-101	HKUST-1
1.90	1.69	0.88

**Density of materials  
(in g cm<sup>-3</sup>)**

# Group



## References

- Peng et al., J. Am. Chem. Soc. 2013, 135, 11887–11894
- Mason et al., Chem. Sci. 2014, 5, 32-51